THAT WHICH IS CLAIMED IS:

1. A method of modeling a three-dimensional object, comprising the step of:

generating a model of a three-dimensional surface of the object from a second plurality of points that define a coarse digital representation of the three-dimensional surface and a texture map containing information derived by mapping points within the texture map to a fine digital representation of the three-dimensional surface that is defined by a first plurality of three-dimensional points.

2. The method of Claim 1, wherein said generating step is preceded by the step of scanning a three-dimensional colored object to obtain a colored point cloud representation of the colored object.

3. The method of Claim 2, wherein said scanning step is followed by the step of wrapping the colored point cloud representation of the colored object to obtain the first plurality of three-dimensional points as a first plurality of three-dimensional colored points.

4. The method of Claim 1, wherein the first plurality of three-dimensional points are colored points; and wherein said generating step comprises the steps of:

generating a quadrangulation of the three-dimensional surface from the first plurality of three-dimensional colored points;

converting the quadrangulation into the second plurality of points; and

determining the texture map for the coarse digital representation of the three-dimensional surface by:

determining for a first texel in the texture map a respective texel coordinate that identifies a first spatial point on the coarse digital representation of the three-dimensional surface; and

projecting the first spatial point to a first object point on the fine digital representation of the three-dimensional surface.

5. The method of Claim 4, wherein said step of determining a texture map comprises the step determining a color map by assigning a color associated with the first object point to the first texel.

6. The method of Claim 5, wherein the second plurality of points constitute vertices of a coarse triangulation; wherein the first plurality of three-dimensional colored points constitute vertices of a fine triangulation; and wherein the color associated with the first object point y is determined by a function $\chi(y)$, where:

$$\chi(y) = \alpha\chi(a) + \beta\chi(b) + \gamma\chi(c),$$

abc is a triangle on the fine triangulation that contains y and α, β, γ are the barycentric coordinates of y defined such that $\alpha+\beta+\gamma=1$ and $\alpha a+\beta b+\gamma c=y$.

7. The method of Claim 4, wherein said converting step comprises the steps of:

decomposing the quadrangulation into a quadrangular grid; and

decimating the quadrangular grid through a sequence of track contractions that are prioritized by an error function.

8. The method of Claim 4, wherein said converting step comprises:

decomposing the quadrangulation into a quadrangular grid;

creating a dual graph of the quadrangular grid; and

removing whiskers from the dual graph using a simplification operation that is driven by a priority queue that orders whiskers by a respective error their removal causes to the quadrangular grid.

9. The method of Claim 8, wherein the respective error is a mean square error.

10. The method of Claim 1, wherein said generating step comprises the step of:

determining the texture map for the coarse digital representation of the three-dimensional surface by:

determining for a first texel in the texture map a respective texel coordinate that identifies a first spatial point on the coarse digital representation of the three-dimensional surface; and

projecting the first spatial point to a first object point on the fine digital representation of the three-dimensional surface.

11. The method of Claim 10, wherein said step of determining a texture map comprises determining a color map by assigning a color associated with the first object point to the first texel.

12. The method of Claim 10, wherein said step of determining a texture map comprises determining a displacement map by assigning a height difference between the first spatial point and the first object point to the first texel.

13. The method of Claim 10, wherein said step of determining a texture map comprises determining a displacement map by assigning a height difference δ(y) between the first spatial point x and the first object point y to the first texel, where

$$y = x + \delta(y) \cdot \mathbf{n}_x$$

and $\mathbf{n}_x$ is a vector that extends in a direction from the first spatial point to the first object point and is normal to the coarse digital representation at the first spatial point.

14. The method of Claim 10, wherein said step of determining a texture map comprises the step of determining a perturbed normal map by assigning a difference between a first normal at the first spatial point and a second normal at the first object point to the first texel.

15. The method of Claim 14, wherein said step of determining a texture map comprises the step of determining a perturbed normal map by constructing an orthonormal frame (N, T, B) defined for N = $\mathbf{n}_x$, where T and B are the tangent and binormal directions at the first spatial point, respectively.

16. The method of Claim 15, wherein said step of determining a perturbed normal map comprises determining a triplet $(\lambda,\mu,\upsilon) \in [-1, +1]^3$ where:

$$\mathbf{n}_y = \lambda \cdot N + \mu \cdot T + \upsilon \cdot B$$

and $\mathbf{n}_y$ is a normal vector at the first object point as expressed in the orthonormal frame.

17. The method of Claim 6, wherein patch boundaries of the quadrangulation *Q* trace u-coordinate and v-coordinate lines; and wherein said step of determining a texture map comprises the steps of:

determining a displacement map by assigning a height difference $\delta(y)$ between the first spatial point x and the first object point y to the first texel, where

$$y = x + \delta(y) \cdot \mathbf{n}_x$$

and $\mathbf{n}_x$ is a vector that extends in a direction from the first spatial point to the first object point and is normal to the coarse digital representation of the three-dimensional surface at the first spatial point;

determining a perturbed normal map by:

constructing an orthonormal frame (N, T, B) defined for N $= \mathbf{n}_x$, where T and B are the tangent and binormal directions at the first spatial point, respectively; and

determining a triplet $(\lambda, \mu, \upsilon) \in [-1, +1]^3$ where:

$$\mathbf{n}_y = \lambda \cdot N + \mu \cdot T + \upsilon \cdot B$$

and $\mathbf{n}_y$ is a normal vector at the first object point as expressed in the orthonormal frame.

18. The method of Claim 17, where $T = N \times d / \|N \times d\|$ and $B = T \times N$ and *d* is a direction of a v-coordinate line passing through the first spatial point $x \in Q$.

19. The method of Claim 4, wherein said converting step comprises the steps of:

decomposing the quadrangulation into a quadrangular grid; and

generating an intermediate triangulation from the quadrangular grid using a decomposition operation that preserves vertices of the quadrangular grid and patch boundaries from the quadrangulation.

20. The method of Claim 19, further comprising the step of decimating the intermediate triangulation into a coarse triangulation using a sequence of edge contractions that preserve patch boundaries from the quadrangulation.

21. The method of Claim 1, wherein the first plurality of three-dimensional points are colored points; and wherein said generating step comprises the steps of:

generating a NURBS model from the first plurality of three-dimensional colored points;

converting the NURBS model into the second plurality of points; and

determining the texture map for the coarse digital representation of the three-dimensional surface by:

determining for a first texel in the texture map a respective texel coordinate that identifies a first spatial point on the coarse digital representation of the three-dimensional surface; and

projecting the first spatial point to a first object point on the fine digital representation of the three-dimensional surface.

22. The method of Claim 1, wherein the first plurality of three-dimensional points are colored points; and wherein said generating step comprises the steps of:

generating a quadrangulation of the three-dimensional surface from the first plurality of three-dimensional colored points;

converting the quadrangulation into the second plurality of points; and

constructing the texture map for the coarse digital representation of the three-dimensional surface using a parametrization Ψ of the quadrangular patches on the quadrangulation.

23. The method of Claim 22, wherein said constructing step also comprises:

determining for a first texel in the texture map a respective texel coordinate that, using Ψ^{-1}, identifies a first spatial point on the coarse digital representation of the three-dimensional surface; and

projecting along a normal from the first spatial point to a first object point on the fine digital representation of the three-dimensional surface.

24. The method of Claim 1, wherein the first plurality of three-dimensional points are colored points; and wherein said generating step comprises the steps of:

generating a subdivision surface model from the first plurality of three-dimensional colored points;

converting the subdivision surface model into the second plurality of points; and

determining the texture map for the coarse digital representation of the three-dimensional surface by:

determining for a first texel in the texture map a respective texel coordinate that identifies a first spatial point on the coarse digital representation of the three-dimensional surface; and

projecting the first spatial point to a first object point on the fine digital representation of the three-dimensional surface.

25. A method of modeling a three-dimensional colored object, comprising the step of:

generating a colored model of a surface of the colored object from a coarse triangulation of the surface and a texture map containing information obtained by mapping points within the texture map to a fine triangulation of the surface that has colored vertices derived from three-dimensional colored scan data.

26. The method of Claim 25, wherein said generating step comprises generating the texture map as a color map containing an array of texels; and wherein a first texel in the array of texels retains color information derived from mapping a center and at least a first corner of the first texel to respective spatial points on the coarse triangulation.

27. The method of Claim 26, wherein the first texel retains color information derived from mapping a center and each corner of the first texel to respective spatial points on the coarse triangulation.

28. The method of Claim 27, wherein the color information is derived from mapping the respective spatial points on the coarse triangulation along normal projections to respective object points on the fine triangulation.

29. The method of Claim 25, wherein said generating step comprises generating the texture map as a color map containing an array of texels having a plurality of texture domains therein; wherein a first texture domain in the plurality of texture domains comprises l columns and k rows of texels; wherein a first texel in the lth column of the first texture domain retains color information derived from mapping at least one of a center or corner of the first texel to a first patch on the coarse triangulation; and wherein a second texel in the first texture domain retains color information derived from mapping at least one of a center or corner of the second texel to a second patch on the coarse triangulation that is contiguous with the first patch at a patch boundary.

30. A method of modeling a three-dimensional colored object, comprising the steps of:

generating a coarse triangulation model from a fine triangulation model of a colored object that has colored vertices corresponding to physical locations on the colored object that have been digitally scanned; and

generating a texture map having an array of texture domains therein that retain color information derived by mapping each texture domain to respective quadrangular patches on the coarse triangulation model and mapping spatial points on the quadrangular patches to object points on the fine triangulation model.

31. The method of Claim 30, wherein each of the quadrangular patches on the coarse triangulation model is within a respective grid track that traces a loop.

32. The method of Claim 30, wherein said step of generating a texture map comprises generating the texture map as a color map containing an array of texels having a plurality of texture domains therein; wherein a first texture domain in the plurality of texture domains comprises l columns and k rows of texels; wherein a first texel in the lth column of the first texture domain retains color information derived from mapping at least one of a center or corner of the first texel to a first quadrangular patch on the coarse triangulation model; and wherein a second texel in the first texture domain retains color information derived from mapping at least one of a center or corner of the second texel to a second quadrangular patch on the coarse triangulation model that is contiguous with the first quadrangular patch at a patch boundary.

33. A method of modeling a three-dimensional colored object, comprising the steps of:

capturing colored shape detail as three-dimensional point data from a physical object, with each datum comprising three real numbers providing geometric information and three integer numbers providing color information; and

converting the captured color shape detail into a coarse digital model of the physical object and a model enhancing texture map that maps points therein to the coarse digital model and retains color information derived from mapping points within the coarse digital model to a finer digital model derived from the captured colored shape detail.

34. The method of Claim 33, wherein said converting step comprises the steps of:

generating a fine triangulation model of the physical object by wrapping the three-dimensional point data;

generating a fine quadrangular grid model of the physical object by shaping the wrapped point data; and

simplifying the fine quadrangular grid model into a coarse quadrangular grid model by removing tracks from the fine quadrangular grid model that contribute relatively little to the shape of the fine quadrangular grid model when compared to other tracks within the fine quadrangular grid model.

35. The method of Claim 34, wherein said converting step comprises:

generating a first map that maps each quadrangular patch on the coarse quadrangular grid model to a respective texture domain in the texture map; and

generating a second map that maps spatial points on the coarse quadrangular grid model to object points on the fine triangulation model.

36. The method of Claim 35, wherein the texture map is created so that each texture domain has at least two texels therein that map to different patches on the coarse quadrangular grid model.

37. A method of modeling a colored object, comprising the steps of:

automatically generating a triangulation model of the colored object that is defined by a plurality of quadrangular patches that extend within respective continuous grid tracks that loop around the triangulation model, from three-dimensional colored scan data that identify location and color of points on the colored object; and

generating a texture map that contains information derived from mapping spatial points on the triangulation model to object points on another model derived from the colored scan data.

38. The method of Claim 37, wherein the texture map comprises a plurality of texture domains; and wherein a first texture domain in the plurality of texture domains includes interior texels that map to a first quadrangular patch in the triangulation model and peripheral texels that map to at least a second quadrangular patch in the triangulation model.

39. The method of Claim 37, wherein the second quadrangular patch shares a patch boundary with the first quadrangular patch.

40. A method of modeling a three-dimensional colored object, comprising the step of:

generating a colored model of a surface of the colored object from a second plurality of points that define a coarse digital representation of the surface and a texture map containing information derived by mapping points within the texture map to a fine digital representation of the surface that is defined by a first plurality of points.

41. A method of modeling a three-dimensional object, comprising the step of:

generating a texture map having at least a first texture domain therein that comprises at least a first peripheral texel retaining color information derived from mapping the first peripheral texel to a first patch on a quadrangulation model of the three-dimensional object and at least a first interior texel retaining color information derived from mapping the first interior texel to a second patch on the quadrangulation model.

42. The method of Claim 41, wherein the first and second patches share a common patch boundary.

43. A method of modeling a three-dimensional object, comprising the step of:

decimating a fine quadrangular grid model of the three-dimensional object into a coarse quadrangular grid model of the three-dimensional object by removing tracks from the fine quadrangular grid model that contribute relatively little to the shape of the fine quadrangular grid model when compared to other tracks within the fine quadrangular grid model.

44. The method of Claim 43, wherein said decimating step is performed using a sequence of edge contractions that are prioritized by an error function.

45. The method of Claim 43, wherein said decimating step comprises the steps of:

creating a dual graph of the fine quadrangular grid model; and

removing whiskers from the dual graph using a simplification operation that is driven by a priority queue that order whiskers by a respective error their removal causes to the quadrangular grid.

46. A computer program product that models three-dimensional objects and comprises a computer-readable storage medium having computer-readable program code embodied in said medium, said computer-readable program code comprising:

computer-readable program code that generates a coarse triangulation model from a fine triangulation model of a colored object that has colored vertices corresponding to physical locations on the colored object that have been digitally scanned; and

computer-readable program code that generates a texture map having an array of texture domains therein that retain color information derived by mapping texels within the texture domains to spatial points on quadrangular patches on the coarse triangulation model and to object points on the fine triangulation model.

47. The computer program product of Claim 46, wherein said computer-readable program code that generates a texture map comprises computer-readable program code that generates a texture map as a color map containing an array of texels having a plurality of texture domains therein; wherein a first texture domain in the plurality of texture domains comprises l columns and k rows of texels; wherein a first texel in the lth column of the first texture domain retains color information derived from mapping at least one of a center or corner of the first texel to a first quadrangular patch on the coarse triangulation model; and wherein a second texel in the first texture domain retains color information derived from mapping at least one of a center or corner of the second texel to a second quadrangular patch on the coarse triangulation model that is contiguous with the first quadrangular patch at a patch boundary.

48. A computer program product that models three-dimensional colored objects and comprises a computer-readable storage medium having computer-readable program code embodied in said medium, said computer-readable program code comprising:

computer-readable program code that generates a triangulation model of a colored object that is defined by a plurality of quadrangular patches that extend within respective continuous grid tracks that loop around the triangulation model, from three-dimensional colored scan data that identify location and color of points on the colored object; and

computer-readable program code that generates a texture map that contains information derived from mapping spatial points on the triangulation model to object points on another model that is derived from the colored scan data and is finer than the triangulation model.

49. A computer program product that models three-dimensional colored objects and comprises a computer-readable storage medium having computer-readable program code embodied in said medium, said computer-readable program code comprising:

computer-readable program code that decimates a fine quadrangular grid model of the three-dimensional object into a coarse quadrangular grid model of the three-dimensional object by removing tracks from the fine quadrangular grid model that contribute relatively little to the shape of the fine quadrangular grid model when compared to other tracks within the fine quadrangular grid model.

50. The computer program product of Claim 49, wherein said computer-readable program code that decimates a fine quadrangular grid model of the three-dimensional object into a coarse quadrangular grid model of the three-dimensional object, comprises:

computer-readable program code that creates a dual graph of the fine quadrangular grid model; and

computer-readable program code that removes whiskers from the dual graph using a simplification operation that is driven by a priority queue that order whiskers by a respective error their removal causes to the quadrangular grid.